

The impacts of new energy vehicles on fleet average oil consumption of passenger vehicles in China

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Abstract. Using authoritative data and calculation formulas, this paper reveals exactly the role of new energy vehicles (NEV) in the decrease of fleet average oil consumption (FAOC) of passenger vehicles in China. NEV is the reason for the gap among the accounted FAOC, the real FAOC of passenger vehicles and the FAOC of conventional energy vehicles (CEV). Specifically, the NEV multipliers result in the difference between the accounted FAOC and the real FAOC of passenger vehicles, while the low oil consumption and output of NEV result in the difference between the real FAOC of passenger vehicles and the FAOC of CEV. NEV is accelerating the reduction of the FAOC of passenger vehicles in China.

Keywords: Passenger vehicle; Fleet Average Oil Consumption (FAOC); New Energy Vehicle (NEV).

1 Introduction

According to China's corporate average fuel consumption (CAFC) standard for passenger vehicles, since 2016, NEV will be included in the calculation of actual CAFC; Furthermore, NEV output can be counted by a multiplier greater than 1 and its non-oil fuel consumption is excluded (Table 1) [1]. NEV includes battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV) and fuel cell vehicles (FCV). Therefore, the so-called "actual FAOC of passenger vehicles" is actually the accounted FAOC of passenger vehicles, rather than the real FAOC of passenger vehicles, let alone the real fleet average fuel consumption (including non-oil fuel consumption) of passenger vehicles.

Table 1. NEV's preferences in actual CAFC calculation.

Year	2016	2017	2018	2019	2020
NEV Multiplier	5	5	3	3	2
Favor for NEV's fuel consumption counting	Only is PHEV's oil consumption counted (excluding electricity consumption of BEV and PHEV, and hydrogen consumption of FCV)				

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Using official data and simple algorithms, this paper calculates the real *FAOC* of China’s passenger vehicles, the *FAOC* of NEV as passenger vehicles and the *FAOC* of CEV as passenger vehicles. This paper reveals accurately the role of NEV in the decrease of *FAOC* for passenger vehicles in China.

2 The *FAOC* of passenger vehicles (2016-2019)

With *FTOC*, *FTOC*₁ and *FTOC*₂ denoting *FAOC* of passenger vehicles, the overall oil consumption of CEV and the overall oil consumption of PHEV (the overall oil consumption of NEV); with *FAOC*₁ and *FAOC*₂ denoting *FAOC* of CEV and *FAOC* of PHEV (*FAOC* of NEV); with *Y*, *Y*₁ and *Y*₂ denoting output of passenger vehicles, output of CEV and output of NEV, then *FTOC* equals the product of *FAOC* and *Y*, *FTOC*₁ equals the product of *FAOC*₁ and *Y*₁, *FTOC*₂ is equal to *FAOC*₂ times *Y*₂, and *FTOC* is equal to *FTOC*₁ plus *FTOC*₂. Then *m* represents the NEV multiplier, so the preferences of NEV in the calculation of actual CAFC means that Formula 1 can be used to calculate the accounted *FAOC* of passenger vehicles (*FAOC*^A).

$$FAOC^A = \frac{FTOC_1+FTOC_2}{Y_1+mY_2} = \frac{FTOC}{Y_1+mY_2} \tag{1}$$

All data in Table 2 are from the official website of the Ministry of Industry and Information Technology (MIIT), which shows the rapid downward trend of *FAOC*^A from 2016 to 2019^[2].

Table 2. Output (million) and accounted *FAOC* (L/100 km) of passenger vehicles.

Year	<i>Y</i>	<i>Y</i> ₁	<i>Y</i> ₂	<i>FAOC</i> ^A
2016	24.4947	24.1673	0.3274	6.43
2017	24.6929	24.1121	0.5808	6.05
2018	23.1391	22.1039	1.0352	5.80
2019	20.93	19.8536	1.0764	5.56

3 The real *FAOC* of passenger vehicles

The real *FAOC* of passenger vehicles (*FAOC*^R) is equal to the total oil consumption of passenger vehicles divided by the total production of the passenger vehicles (Formula 2).

$$FAOC^R = \frac{FTOC_1+FTOC_2}{Y_1+Y_2} = \frac{FTOC}{Y_1+Y_2} \tag{2}$$

According to Formula 1 and 2, Formula 3 and 4 can be deduced.

$$FTOC = FAOC^A (Y_1 + mY_2) = FAOC^R (Y_1 + Y_2) \tag{3}$$

$$FAOC^R = \frac{Y_1+mY_2}{Y_1+Y_2} FAOC^A \tag{4}$$

According to Table 1, 2 and Formula 4, the real *FAOC* of passenger vehicles from 2016 to 2019 can be calculated (Table 3).

Table 3. The real *FAOC* of passenger vehicles (L/100 km).

Year	2016	2017	2018	2019
<i>FAOC</i> ^R	6.77	6.62	6.32	6.13

4 The FAOC of NEV (2016-2019)

The *F_{TOC}* of NEV is equal to the *F_{TOC}* of PHEV. When the total PHEV production and PHEV’s *FAOC* are known, the *FAOC* of NEV can be calculated (Formula 5).

$$FAOC_2 = \frac{F_{TOC_2}}{Y_2} \tag{5}$$

The "PHEV Sales" in Table 4 is used as a substitute for "PHEV Production" (the latter data are not available and the gap between them is very small) [3]. The *FAOC* of PHEV in Table 4 is estimated based on the *FAOC* of BYD Motor Company’s PHEV (BYD’s PHEV sales account for approximately 25% of total PHEV sales).

The *FAOC* of NEV (*FAOC₂*) is shown in Table 4.

Table 4. *F_{TOC}* and *FAOC* of NEV.

Year	PHEV Sales (thousand)	<i>FAOC</i> of PHEV (L/100km)	<i>F_{TOC}</i> ₂ (1000L/100km)	<i>FAOC</i> ₂ (L/100km)
2016	80.562	1.6	128.899	0.39
2017	106.850	1.6	170.960	0.29
2018	241.351	1.5	362.027	0.35
2019	202.180	1.5	303.270	0.28

5 The FAOC of CEV

According to Formula 4 and Table 1, 2, 3 and 4, the *FAOC* of CEV can be calculated (Formula 6 and Table 5).

$$FAOC_1 = \frac{F_{TOC} - F_{TOC_2}}{Y_1} \tag{6}$$

Table 5. *FAOC* of CEV (L/100 km).

Year	2016	2017	2018	2019
<i>FAOC</i> ₁	6.86	6.77	6.6	6.45

Figure 1 shows four types of *FAOC* of passenger vehicles in 2016-2019.

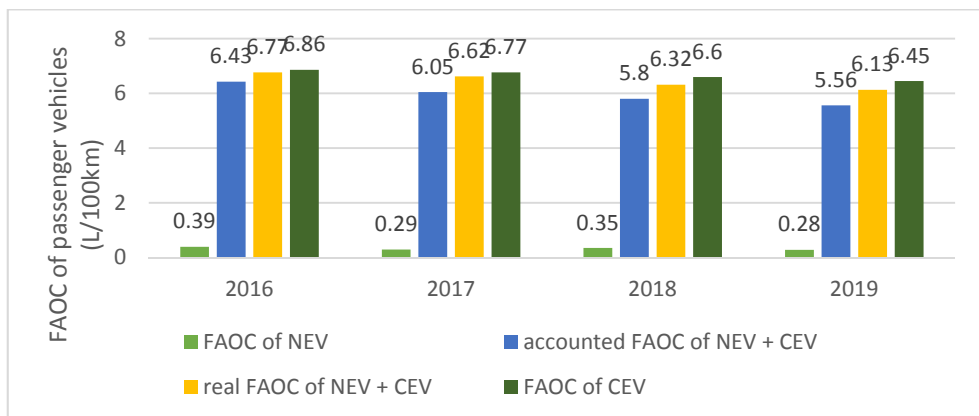


Fig. 1. Four types of *FAOC* for passenger vehicles.

6 The impacts of NEV multipliers on FAOC of passenger vehicles

By comparing Formula 1 and Formula 2, it can be found that the difference between the accounted and the real *FAOC* of passenger vehicles comes from the impact of NEV multiplier. Thus, $FAOC^A - FAOC^R$ can represents the decrease in *FAOC* of passenger vehicles due to NEV multiplier (Table 6).

Table 6. *FAOC* reductions of passenger vehicles caused by NEV multipliers (L/100 km).

Year	2016	2017	2018	2019
$FAOC^A - FAOC^R$	-0.34	-0.57	-0.52	-0.57

7 The impacts of low fuel consumption and output of NEV on FAOC

By comparing Formula 2 and Formula 6, it can be found that the difference between the real *FAOC* of passenger vehicles and the *FAOC* of CEV comes from low fuel consumption and output of NEV. Thus, $FAOC^R - FAOC_1$ can represents the decrease in *FAOC* of passenger vehicles due to low fuel consumption and output of NEV (Table 7).

Table 7. *FAOC* reductions caused by low fuel consumption and output of NEV (L/100 km).

Year	2016	2017	2018	2019
$FAOC^R - FAOC_1$	-0.09	-0.15	-0.28	-0.32

8 The total impacts of NEV on FAOC

The total effect of NEV on *FAOC* of passenger vehicles is equal to $FAOC^A - FAOC_1$, or to the sum of the two effects mentioned above (Table 8).

Table 8. Total decreases in *FAOC* of passenger vehicles caused by NEV (L/100 km).

Year	2016	2017	2018	2019
$FAOC^A - FAOC_1$	-0.43	-0.72	-0.8	-0.89

Figure 2 shows the decreases of *FAOC* of passenger vehicles caused by NEV.

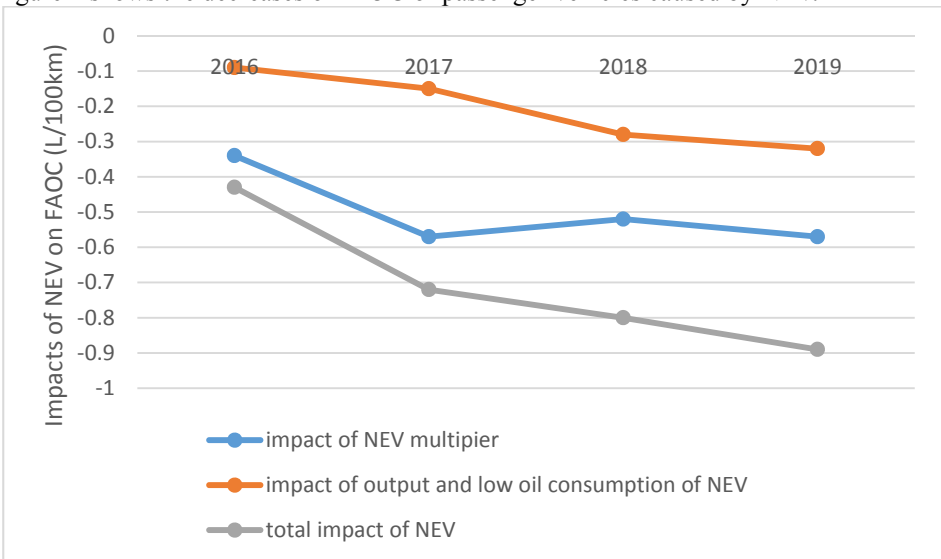


Fig. 2. *FAOC* reductions of passenger vehicles caused by NEV.

9 Conclusions

In each year from 2016 to 2019, the *FAOC* of NEV, the accounted *FAOC* of passenger vehicles, the real *FAOC* of passenger vehicles and the *FAOC* of CEV increase in turn. The differences between the accounted and the real *FAOC* come from the impacts of NEV multipliers, while the differences between the real *FAOC* of passenger vehicles and the *FAOC* of CEV come from low oil consumption and output of NEV. The cumulative effect of NEV on the *FAOC* of passenger vehicles is equal to the sum of the above two effects, and this total effect shows a trend of gradual increase.

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